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ABSTRACT

Reporting and interpreting (corrected) effect size indices can help readers of scientific reports understand the importance of those results more fully instead of just determining the likelihood of results assuming the null hypothesis. This study explored the frequency of effect reporting and interpretation in quantitative studies in "Communication Education," the flagship instructional communication journal of the National Communication Association. More than half of the 14 studies identified as using statistical analysis (57%) reported effect sizes, and the majority of these (88%) interpreted these effects. The paper discusses the implications of effect reporting and interpretation and present some examples of effect interpretation. (Contains 26 references.) (Author/SLD)

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In Search of OZ:

Effect Size Reporting and Interpretation in Communication Research

Holly M. Hutchins and Robin K. Henson

University of North Texas

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Abstract

Reporting and interpreting (corrected) effect size indices help readers of scientific reports more fully understand the importance of those results, rather than just the likelihood of results assuming the null hypothesis is true. This paper explores the frequency of effect reporting and interpretation in an analysis of quantitative studies in *Communication Education*, the flagship instructional communication journal of the National Communication Association. Over half of the studies (57%) reported effect sizes and the majority of those (88%) interpreted these effects. The authors discuss implications concerning effect reporting and interpretation and include good examples of effect interpretation.

In Search of OZ: Effect Size Reporting and Interpretation in Communication Research

Girl with ruby slippers travels with cohorts in search of passage back to Kansas. Girl is told that a being named OZ is all-powerful and all-knowing and will be able to provide meaningful answers to inquiries. Girl and companions—person of little scruples, person without a heart, and person of questionable courage—ultimately discover OZ is no more than a façade merely appearing to have the final word on such quandaries and does not, in the end, provide complete assistance in helping girl get back to Kansas.

This oversimplification of the *Wizard of Oz* is symbolic of the growing need in research circles to add stronger support to statistical significance testing by reporting and interpreting effect size indices. For too long, researchers have boldly proclaimed that the importance of their study exist with the probability value (p-value). By providing effect sizes, researchers are strengthening their claims with both magnitude of effect and practical significance, both of which a p-value cannot and does not speak to. Reporting and interpreting effect size indices help readers of scientific reports more fully understand the importance of those results, rather than just the likelihood of results assuming the null hypothesis is true. In short, and in keeping with the metaphor, p-values do not completely help researchers get to Kansas! If the p-value is OZ, then effect size reporting and interpretation may just be the ruby slippers needed to help researchers facilitate a better understanding of what their results mean.

Of course, effect sizes are not magical, but useful for evaluating how noteworthy the research findings are. Nevertheless, the movement toward reporting effects in addition to or instead of p-values has developed some inertia. As a reflection of this trend, the following known journals now require that an effect index be reported along with p-values (Vacha-Haase, 2001):

Career Development Quarterly
Contemporary Educational Psychology
Educational and Psychological Measurement
Exceptional Children
Journal of Agricultural Education
Journal of Applied Psychology
Journal of Community Psychology
Journal of Consulting & Clinical Psychology
Journal of Counseling and Development
Journal of Early Intervention
Journal of Educational and Psychological Consultation
Journal of Experimental Education
Journal of Learning Disabilities
Language Learning
Measurement and Evaluation in Counseling and Development
The Professional Educator
Research in the Schools

Purpose

Several articles have reviewed the current state of effect reporting (cf. Henson & Smith; Vacha-Haase, Nilson, Reetz, Lance, & Thompson, 2000). These empirical reviews were conducted largely for educational and psychological journals and suggest effect sizes are still often omitted from research articles. However, few recent reviews exist for the communication research literature (Chase & Simpson, 1979; Holley & Barker, 1979; Kutzer & Sodt, 1973) and therefore it is unclear the degree that authors are currently including effects in communication articles. Therefore, this paper examined reporting practices within quantitative research reports published in the National Communication Association's flagship journal on instructional communication, *Communication Education*. An explanation of effect size reporting and interpretation is provided as background for the present study and to establish the need for reporting effect sizes in research as set out by the American Psychological Association (APA) *Publication Manual* (APA, 2001) and current trends. The authors present and explain findings

from a review of quantitative studies published in *Communication Education* during the year 2000.

Effect Size Reporting

Effect size, in its simplest form, describes the degree of difference in the dependent measure accounted for by the presence or absence of the independent measure (Holley & Barker, 1979), or the degree of relationship between variables. As used by some, an effect size augments the statistical significance test by determining how strong or meaningful, subsequent to a researcher interpretation, a treatment, measure, or variable's relationship with the dependent variable. Without assessing effect sizes, a researcher knows only that a difference or relationship exists, but not how important, useful, or big that difference is. Thompson (1994)—and to date, the 5th edition of the APA *Publication Manual* (APA, 2001)—noted that semantically stating just that results are "significant" implies that such are especially important, noteworthy, or "practically" significant. Statistical significance, however, does not necessarily equate practical significance. By using effect size estimates, researchers can probe their data to determine the practical significance (importance) of their results (Cohen, 1994; Roberts & Henson, in press; Thompson, in press).

Given the importance of reporting effects, Snyder and Lawson (1993) argued that researchers should understand both the categories of effect estimates and the details inherent to calculating effects in order to correctly use such in their analysis and reporting. A brief review of these concepts follows.

Mean Difference vs. Variance-Accounted-For Effects

Two general categories of effects exist: those that involve directly examining differences between means and those that involve proportions of variance (e.g. variance-accounted-for

estimates). Examples of effects concerning mean differences include mean difference indices and standardized differences between means (such as Cohen's *d*). These indices help explain the degree of group differences that exist.

In comparison, variance-accounted-for estimates describe the amount of variability explained or predicted by the independent variable in the dependent variable. Examples of these indices include eta^2, partial eta^2, $omega^2$, $epsilon^2$, $\underline{R}^2$, partial $\underline{R}^2$, Ezekiel formula, Herzberg formula, and the Lord formula (Snyder & Lawson, 1993). While different, both are related in the general linear model in that Cohen's *d* can be converted to an r^2-type effect, due to the correlational nature of all data analytic procedures (Cohen, 1994).

Uncorrected vs. Corrected Effects

Furthermore, two types of variance-accounted-for effect size estimates exist. Also called biased magnitude of association estimates, uncorrected effect estimates can be explained as the ratio of explained variance to total variance. Examples of these include eta^2 (as used in ANOVA) and $\underline{R}^2$ (as used in regression). These estimates are often referred to as *biased* because they capitalize on sampling error and tend to overestimate the population effect or the effect in future samples (Roberts & Henson, in press; Snyder & Lawson, 1993; Yin & Fan, 2001).

Corrected effect estimates (unbiased magnitude of association estimates), conversely, attempt to statistically correct for the positive bias that occurs in uncorrected estimates. Using corrected effect estimates allow the researcher to better estimate the true population effect—which bolsters the generalizability of one's results to future samples—and hence, are recommended for use in analysis and in the interpretation of results (Snyder & Lawson, 1993; Thompson & Kieffer, 2000). Various formulas exist for computing corrected effect sizes. Examples of these estimates include adjusted $\underline{R}^2$ (Ezekiel formula often used in regression) and

omega^2 (ANOVA). Adjusted $\underline{R}^2$ is automatically calculated for regression procedures by most statistical packages even when not requested, however the actual calculation is:

$$\text{Adj. } \underline{R}^2 = \underline{R}^2 - ((1 - \underline{R}^2) * (\underline{v} / \underline{n} - \underline{v} - 1)),$$

where $\underline{R}^2$ is the sample effect, $\underline{v}$ is the number of predictors, and n is the sample size. The omega^2 estimates can be expressed as:

$$\text{omega}^2 = (SS_{BETWEEN} - (\underline{k} - 1) \times MS_{WITHIN}) / (SS_{TOTAL} + MS_{WITHIN}),$$

where k is the number of groups (Hinkle & Wiersma, 1998).

Effect Size Interpretation

Along with reporting effect sizes, researchers are also encouraged to interpret these in their discussion of results. Failure to discuss the meaning of one's effect does not help in determining whether or not the difference detected is important, useful, or practical (Thompson, 1996). A significant issue of concern surrounding the interpretation of effect sizes is the current position stated in the 5th edition of the APA *Publication Manual* (APA, 2001). Additional issues concern interpreting effect size in lieu of sample size and a possible error in SPSS for Windows with eta^2.

APA Publication Manual

Most social science journals require articles to conform to the APA *Publication Manual* for style. The 4th edition of the *Publication Manual* addressed the lack of specificity innate to p-values by "encouraging" researchers to either report effect sizes or provide the reader the means by which to calculate the effect size (test statistic and sample size/degrees of freedom) in their research results. However, few researchers heeded the call as evidenced by reviews of effect reporting (Henson & Smith, 2000; Vacha-Haase et al., 2000). The debate over statistical significance testing prompted the APA to convene a formal discussion (APA Task Force on

Statistical Inference) to review the many issues researchers and methodologists were discussing at conferences, journals, and meetings regarding statistical significance testing. Harlow, Mulaik, and Steiger (1997) provide a balanced discussion of the debate. In its report (Wilkinson & APA Task Force on Statistical Inference, 1999), the Task Force set out several suggestions for reporting statistically significant tests and argued that effect sizes should be reported and interpreted. Despite the APA Task Force's mandate for effect size reporting and interpretation, the 5th edition of the *APA Publication Manual* (2001) stopped short of issuing an explicit requirement. Nevertheless, the 5th edition *Publication Manual* suggests there is seldom an occasion when effects should not be reported. According to the *Publication Manual* (APA, 2001):

> For the reader to fully understand the importance of your findings, it is almost always necessary to include some index of effect size of strength of relationship in your Results section…The principle to be followed, however, is to provide the reader not only with information about statistical significance but also with enough information to assess the magnitude of the observed effect of relationship. (pp. 25-26)

Thompson and Snyder (1997) further suggested that,

> …explicitly and reflectively linking research results in a given study to the effect sizes in previous studies is also a vehicle for evaluating result repliciability. This can be done prospectively by formulating null hypotheses incorporating specific parameter expectations derived from previous research, as against the contemporary practice of always testing hypotheses of no difference or of no relationship (i.e., what Cohen, 1994, described as "nil" hypothesis testing). (p. 80)

The APA Task Force (Wilkinson & APA Task Force on Statistical Inference, 1999) concurred, "We must stress again that reporting and interpreting effect sizes in the context of previously reported effects is essential to good research. It enables readers to evaluate the stability of results across samples, designs, and analyses" (p. 599).

Sample Size

One issue that the 4th edition *Publication Manual* spoke more directly to (than the 5th edition does) is the impact of sample size on statistical significance testing. According to the 4th edition *Publication Manual* (APA, 1994), "the ways of reporting probability values do not reflect the importance or magnitude of an effect or strength of a relationship because the probability values depend on sample size…[therefore] you are encouraged to provide effect size information" (p. 18). Put another way, statistically significant results are bound to occur if the sample size is large enough (Henson & Smith, 2000). When the sample size is small, samples contain more sampling error and "flukiness" (Thompson, 1996, p. 27) and will typically yield larger $p_{CALCULATED}$ values. Large samples, conversely, will yield smaller $p_{CALCULATED}$ values likely giving way to statistically significant results. Thompson (1996) referred to statistical significance testing as merely a test of "researcher endurance" (p. 27) in that results will be statistically significant, albeit not guaranteed to be practically significant, when one has rounded up enough participants in his/her sample.

Therefore, statistical significance tests should be interpreted in light of the sample size used to compute the p-value. Further, such tests should be viewed in light of the observed effect that is being tested. Small (perhaps immaterial) effects can be statistically significant at large sample sizes; large (perhaps noteworthy) effects may not be statistically significant if the study suffers from a small sample size and lack of power.

"What If" Analyses

In an attempt to clarify the conundrum of sample size influence on statistical significant testing, Thompson and Kieffer (2000) offered the "what if" analysis to aid researchers in interpreting their results through the lens of sample size and effect size. In brief, "what if" analyses assesses at what sample size the study results would either become statistically significant or not, keeping (corrected) effect size constant. The benefit of such an approach is that it reveals whether or not a slight (or dramatic) difference in sample size would still yield a statistically significant result or cause the loss of statistical significance. As Snyder and Lawson (1993) noted, such a post hoc power analysis can be an important "result interpretation aid" (p. 33) and can prevent researchers with large samples from overinterpreting their small effects once they see that with a difference of a few participants in their sample, their results would no longer be statistically significant. The same is true for researchers with large effects, in that they can demonstrate a statistically significant result would also have occurred with a smaller sample size (Thompson & Kieffer, 2000).

Possible Concerns

A possible error in the interpretation of eta^2 has been noted by Levine and Hullett (2000) in SPSS for Windows. They found that partial eta^2 was reported as eta^2 on the printouts even though it was correctly noted to be partial eta^2 in the software documentation. Such an error may cause an overinterpretation of effect and could prove problematic for researchers using it to measure effect in a factorial way ANOVA or in meta-analyses where many effect sizes across studies are assessed (Levine & Hullett, 2000).

Effect Size Reporting and Interpretation in *Communication Education*

As early as the 1970's, the debate about "meaningful and trivial" results was occurring in the communication discipline (Chase & Simpson, 1979; Holley & Barker, 1979; Katzer & Sodt, 1973). As mentioned before, journals that require such reporting *(Communication Monographs* and *Human Communication Research*) are among the few in the National Communication Association's arsenal of seven internationally recognized publications. Katzer and Sodt (1979) conducted a similar analysis of effect size reporting and interpretation in articles published in the 1971 and 1972 volumes of the *Journal of Communication.* The authors were concerned with four issues in their analyses: (a) whether journal articles reported effect sizes, (b) if effect sizes were not reported, did sufficient information exist to compute the effect size, c) whether the author(s) interpreted the effect size (rather than just reporting it), and (d) if effect sizes were confused with probability values (alpha or p). They found that only one researcher (out of 22) actually reported (and interpreted!) the effect size in their results. In lieu of these results, Katz and Sodt (1973) issued a staunch directive to communication researchers in terms of reporting effect size estimates in their studies: "If researchers feel compelled to affect the tentative model of communication, then it is even more important for OES [observed effect size] measures to be routinely reported (p. 256).

Method

The present paper presents a review similar to that of Katzer and Sodt (1973). However, we focused our attention specifically on effect reporting and interpretation. Kirk (1996) noted higher frequency of effect reporting in regression research likely due to the fact that most statistical software packages routinely provide variance-accounted-for effects in their output. Our attention concerned two primary issues: (a) what articles reported (variance-accounted-for) effect

sizes for statistically significant results, and (b) did the author(s) interpret the effect size in their discussion of findings.

To explore these issues, we analyzed articles published in the 2000 volume of *Communication Education*. Excluding book reviews, reports, and essays, 14 articles that used statistical analysis were published during that year. For each article, we identified the major statistical test, the number of statistically significant results, whether authors reported effects and, if so, which effect size indices were used, and whether authors interpreted their effects.

Results and Discussion

In the fourteen articles studied, 420 statistical tests were employed. Of these, 216 yielded statistically significant results. A discussion of effect reporting and interpretation practices in the fourteen articles follows.

Effects Reported

Eight articles (57%) reported effect sizes for their statistically significant results. This results stands in stark contrast to Katzer and Sodt's (1973) finding of 4.5 percent and is incredibly high given that *Communication Education* does not specifically require that authors report (or interpret) effects in their submission policy, rather just that manuscripts must abide by the current APA *Publication Manual*. The effect sizes used most were eta^2 (50%) and $\underline{R}^2$ (30%), with $omega^2$ and Cohen's *d* used in the remaining studies. As noted earlier, both eta^2 and $\underline{R}^2$ are uncorrected effect estimates and tend to overestimate population effects or the effect in future samples. As most researchers are concerned about the generalizability of their findings, use of corrected effects may be more applicable.

Effects Interpreted

Of the eight articles that reported effects, seven (88%) interpreted the effect size in their discussion. Each discussed the implications of the effects differently, but all emphasized how important and thus practically significant the results were, beyond the statistically significant p-value result. For example, in a study comparing techniques for helping students manage high communication apprehension (CA), Dwyer (2000) argued that while skills training via a public speaking course did help high CAs reduce their anxiety level, the Multidimensional Model had a "significantly greater impact". The authors described the Model as a "highly effective way to help students reduce CA" in interpersonal and public contexts and that it "extends the possibilities for intervention and instruction" in a communication course (p. 78). Another good example of effect interpretation is in a study that explores the relationships between interactive television instructors' perceptions of students' nonverbal responsiveness and the influence of these perceptions on distance teaching. Mottet (2000) found that interactive television instructors perceived more of their students nonverbal responsive behaviors, formed more positive student impressions, evaluated themselves as being more effective with their teaching style and in the relationships formed with students when in the two-way audio/video condition that in the two-way audio/one-way video. In terms of effect, Mottet (2000) argued:

> …the largest impact was that of the nonverbal responsiveness measure measures and the teacher-student interpersonal relationship measure. The interactive capabilities accounted for 13% of the variance in the higher-interference nonverbal responsive measure and 14% of the variance in the low-interference nonverbal audible measure. Additionally, the interactive capabilities of the technology accounted for 13% of the variance in the teacher-student interpersonal relationship measure. (p. 160)

Finally, King, Young, and Behnke (2000) explained a low effect size ($eta^2 = .085$) in a study comparing immediate versus delayed feedback in improving public speaking through the ComET system. They contended that while the Hawthorne effect may have been at work in the groups that received immediate feedback in having a more positive attitude (compared to the delayed feedback group), they stated "it is hopeful and noteworthy that such systems may be used to supplement traditional instruction with no apparent loss of positive affect nor increase in performance anxiety" (p. 372).

Conclusion

Communication researchers are encouraged to report and interpret (corrected) effect indices in their research. Such reporting and interpretation aids both the reader and the researcher understands more fully the results at hand. Results become "more understandable, and [such reporting and interpretation] facilitates informed reader judgment regarding the trustworthiness and noteworthiness of the results" (Thompson, 1999, p. 332). Such credibility is important as the National Communication Association puts forth various initiatives to increase both the visibility and acceptance of communication research among public and private granting agencies, within the databases and evaluation programs of the National Research Council and the Department of Education, and while influencing policy makers who design laws that govern communication practices (Applegate, 2001, p. 3).

Many social scientists call on textbook authors, journal editors, and publication manuals to lead the way to proper reporting and interpretation of data-analytic techniques (Hyde, 2001; Vaccha-Haase, 2001). Clearly, *Communication Education* boasts a healthy composite of effect reporting and interpretation in the issues reviewed, but that number could be 100% if the editorial policy would require such reporting and explanation of effects rather than relying on a

precarious interpretation of the APA *Publication Manual* guidelines. In the 4th edition *Publication Manual*, the mere "encouraging" of effect size reporting sends a contradictory message that some reporting requirements count while others do not (Thompson, 1999). Fortunately, the 5th edition *Publication Manual* is more direct. As social science research continues to move toward effect reporting and interpretation, communication researchers would do well to embrace this methodological reform. Perhaps *Communication Education* could consider an editorial policy to help facilitate this outcome.

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Organization/Address: Dept. of Technology and Cognition P.O. Box 311337 Denton, TX 76203-1337	Telephone: 940-369-8385	Fax: 940-565-2185
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